

ABSTRACT OF THE DISCLOSURE

An ultrasonic flow meter has been adapted for such measurements in the submarine environment. Connected to a collection funnel, the meter houses two piezoelectric transducers mounted at opposite ends of a cylindrical flow tube. By monitoring the perturbations of fluid flow on the propagation of sound waves inside the flow tube, the ultrasonic meter can measure both forward and reverse fluid flows in real time. Laboratory and field calibrations show that the ultrasonic meter can resolve groundwater discharges in both the forward and reverse directions on the order of 0.1 $\mu\text{m/s}$ ($<1\text{ cm/d}$), and it is sufficiently robust for deployment in the field for several days. Data collected with the meter elucidate the temporal and spatial heterogeneity of submarine groundwater discharge and its interplay with tidal loading and other driving forces. A negative correlation between the discharge and tidal elevation can be observed.